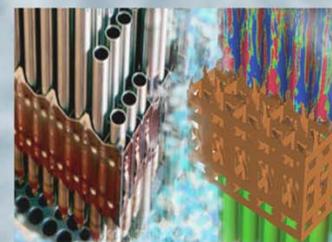
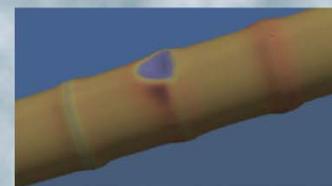
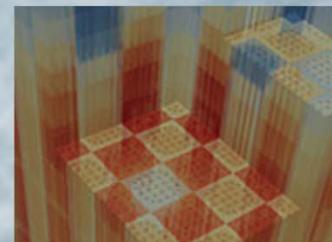




CASL Industry Council Meeting

ALOFT Hotel, Greenville, SC

April 12-13, 2016



Industry Council Meeting

Mission : Assure that CASL products are “used and useful” by industry

Meeting Objectives



Exchange of information about CASL’s research and activities to:

1. Provide an opportunity for engagement between industry stakeholders and CASL researchers.
2. Present and seek feedback on the progress on CASL’s R&D activities and plans.
3. Discuss CASL and industry priorities to ensure that they are aligned.
4. Identify strategic collaborations between industry and CASL Focus Areas.

Industry Council Members

Owner/ Operators of Nuclear Plants	Fuel and/or SMR Vendors	Engineering Design, Service Providers, R&D	Independent Software Vendor	Computer Technology Companies	Ex-Officio
      	    	    	   	  	<p data-bbox="1785 812 1879 852">BOD</p> <p data-bbox="1785 1218 1879 1258">DOE</p>

Industry Council Updates

- Industry Council leadership change
 - Erik Mader (EPRI) will serve as Director
- New Members
 - Enercon Federal Services

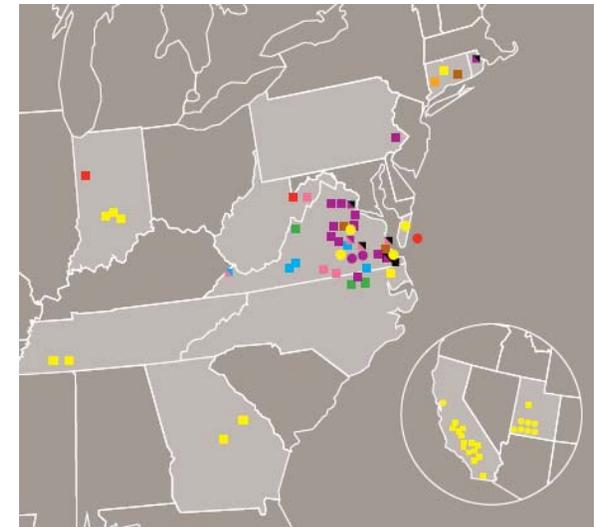
Nuclear Plant Owners





Dominion Overview

- Overview
 - Serves utility and retail customers in 14 states
 - 24,300 MWe generation by diverse assets
 - 63,800 miles of electric transmission and distribution lines
 - 34,200 miles of gas trans, dist, gathering and storage pipeline
 - Gas acquisitions and major expansions of gas infrastructure (Cove Point, Atlantic Coast Pipeline)
 - Nuclear generation supported by licensed in-house methods for reload core design and safety analysis
- Nuclear Plants
 - Millstone 2 – 869.5 MWe 1975 (2035) CE 4-Loop
 - Millstone 3 – 1210 MWe 1986 (2045) W 4-Loop
 - Surry 1 & 2 – 1676 MWe 1972,1973 (2032, 2033) W 3-loop
 - North Anna 1 & 2 – 1892 MWe 1978, 1980 (2038, 2040) W 3-loop
- CASL interests
 - Advancing the state of the art, analytical benchmarks



GENERATION STATIONS
IN OPERATION

- Biomass
- Coal
- Fuel Cell
- Hydro
- Natural Gas
- Nuclear
- Oil/Gas
- Solar
- Wind

GENERATION STATIONS
PLANNED/UNDER DEVELOPMENT

- Natural Gas
- Offshore Wind
Demonstration Project
- Solar



APS Overview

- Overview
 - Owner/Operator of Palo Verde Nuclear Generating Station, Largest Single Site Power Producer in US since 1992
 - Performs in-house core designs, reload designs and non-LOCA accident analyses
 - No fuel failures since U2C14, March 2008 (mfg. defect); U1 failure 2005 (GTRF); U3 failure 2004 (GTRF)
- CASL Interests
 - Advancing state of knowledge
 - Improving production codes & eventual licensure
- Nuclear Plants
 - PVNGS 1, 2 & 3, 1986, 1986, 1988
 - Combustion Engineering System 80
 - Current RTP → 3990 MWth per Unit
 - Units 1, 2 & 3 are licensed to operate through 2045, 2046 & 2047



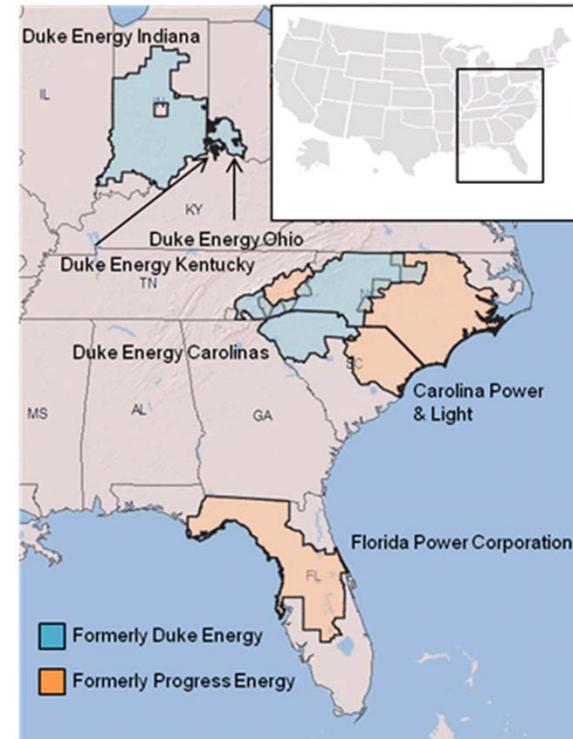


Duke Energy

- Overview
 - Largest US Electric Utility
 - 2012 Merger with Progress Energy
 - Duke self-performs non-LOCA Safety Analyses

- CASL interests
 - Challenge Problems
 - Advancing state of knowledge
 - Improving production codes

- Nuclear Plants
 - Brunswick 1&2 2923 MWt 1975, 1977 (2034) BWR Mark I containment.
 - Catawba 1&2 3411 MWt 1985, 1986 (2043) W 4-loop, Ice Condenser Containment
 - McGuire 1&2 3411 MWt. 1981,1984 (2046) W 4-loop, Ice Condenser Containment
 - Harris 1 2948 MWt 1987 (2046) Westinghouse 3-loop
 - Robinson 2 2339 MWt 1971 (2030) Westinghouse 3-loop.





- Overview
 - Approximately 32,700 megawatts of owned capacity comprising one of the nation's cleanest, lowest-cost power generation fleets.
 - Constellation provides energy products and services to approximately 2 million residential, public sector and business customers, including more than two-thirds of the Fortune 100.
 - Exelon's six utilities deliver electricity and natural gas to approximately 10 million customers in Delaware, the District of Columbia, Illinois, Maryland, New Jersey and Pennsylvania through its Atlantic City Electric, BGE, ComEd, Delmarva Power, PECO and Pepco subsidiaries.

- CASL interests
 - Currently working with the University of Illinois to evaluate the impact of load follow on PCI using BISON

- Nuclear Plants
 - 22 Units (8 PWRs, 14 BWRs) at 13 sites
 - Braidwood, Byron, Clinton, Dresden, LaSalle, Quad Cities, Limerick, Oyster Creek, Peach Bottom, TMI, Calvert Cliffs, Nine Mile Point, and Ginna

Fuel and SMR Vendors



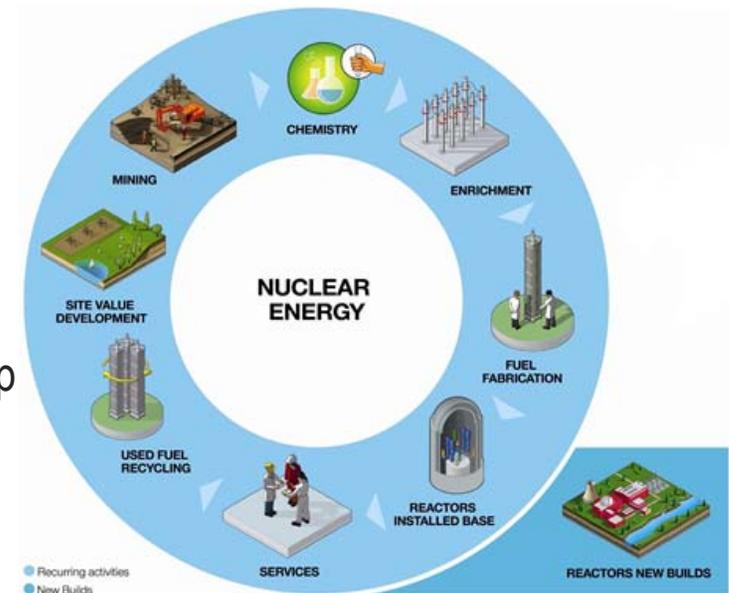


AREVA Overview

- Overview
 - Global Nuclear Supplier (Access to all Things Nuclear)
 - Refocusing on Core Nuclear Processes, EDF Partnership
 - Nearly 40,000 Employees Worldwide

- CASL interests
 - Advancing Analytical Capabilities
 - Improving Computation Capabilities
 - Challenge Problems and Results

- AREVA in the United States
 - Fuel Manufacturing and Engineering Analyses for BWR and PWR Reactors
 - 35 Facilities, Industrial and Commercial, in 20 States
 - Nearly 5,000 Employees





BWXT Overview

BWX Technologies Inc. (BWXT) is a leading supplier of nuclear components and fuel to the U.S. government; provides technical, management and site services to support governments in the operation of complex facilities and environmental remediation activities; and supplies precision manufactured components and services for the commercial nuclear power industry.

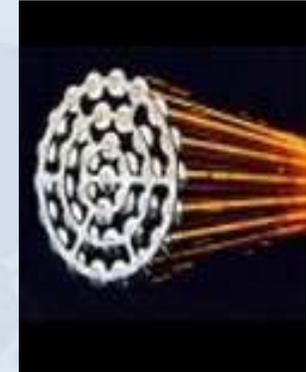
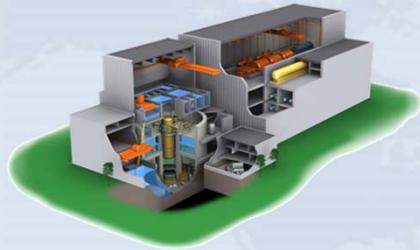
Company Overview

- BWXT operates six major manufacturing facilities
- ~5,400 employees worldwide, ~4,000 with U.S. federal security clearances
- Skill sets include scientists, engineers, machinists, technicians and administrators
- Nuclear Regulatory Commission (NRC) licenses for our nuclear fuel facilities in Lynchburg, VA and Erwin, TN
- Nuclear plant development projects
 - mPower, Terrapower
 - Accident tolerant fuels
- CASL Interests
 - Tool for Evaluation Model V&V
 - Mission for CAER-IST as a NSUF
 - Challenge Problems

Locations



GE Hitachi nuclear alliance and businesses



Wilmington, NC
USA



Tokyo, Japan



Wilmington, NC
USA



Wilmington, NC
Yokosuka, Japan



Peterborough, ON
Canada

- 2 P&Ls operating globally
- 2,800+ employees worldwide
- Nuclear Power Plants: ABWR, ESBWR and PRISM
- Nuclear Services

- Uranium Enrichment



- Uranium Services
- Nuclear Fuel FabricationBWR and CANDU
- CANDU Services
- Fuel Engineering and Support Services

NuScale Overview

- More than 600 people currently working with NuScale. Offices in:
 - Business Offices: Portland, OR; London, UK; Idaho Falls, ID
 - Engineering Offices: Corvallis, OR; Charlotte, NC; Richland, WA
 - Licensing Office, Rockville, MD
- Total cumulative investment by end of 2016 will be ~ \$500M
- NuScale has teamed with AREVA, ARES, Rolls Royce, **Ultra**, and Enercon
- Major testing facilities in US, Canada, Italy, France and Germany
- Intend to submit Design Certification Application to NRC end of 2016
- First COLA to be submitted in 2018



NuScale Engineering Offices Corvallis



Test & Engineering Facilities

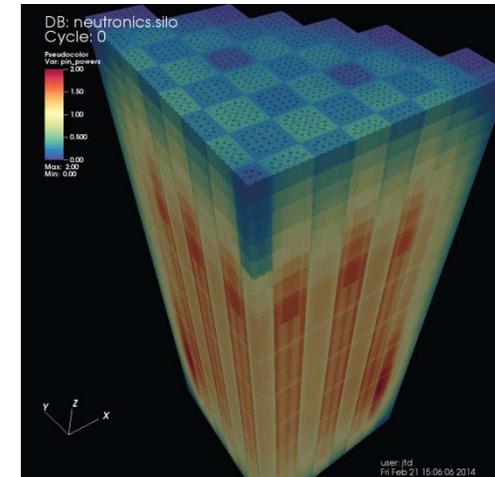
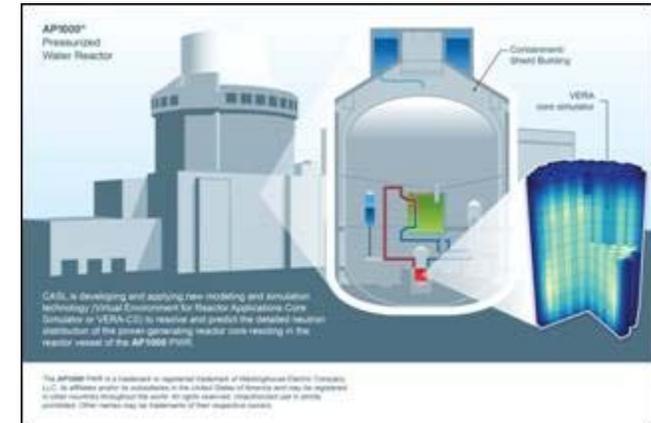


NuScale Control Room Simulator



Westinghouse Overview

- Overview
 - Westinghouse provides fuel, services, technology, plant design, and equipment for the commercial nuclear electric power industry.
 - Westinghouse is proud to be a CASL Founding Partner
- Key Contributions
 - Definition of CASL challenge problems
 - Data for validation
 - Support to Virtual Environment for Reactor Applications (VERA) code and models
 - Development of test stand for VERA tools
 - Initial application of VERA tools
- Key Outcomes
 - Test stand for VERA tools
 - Improved understanding of challenge problems
 - Validation of new models and tools
 - VERA tools for industry applications



Engineering Design, Service Providers, R&D

Battelle

 **ENERCON**
FEDERAL SERVICES, INC.

 **BMPC**
BECHTEL MARINE PROPULSION CORPORATION

EPR2

 **Rolls-Royce**



The logo for BMPC Interest features a stylized green and blue atom symbol to the left of the text 'BMPC Interest'. Below 'BMPC' is the text 'BECHTEL MARINE PROPULSION CORPORATION' in a smaller, green font.

- Benchmark BMPC Advanced Simulation Methods
 - Common PWR Benchmark with other leaders in advanced simulation (e.g., Multiphysics) field
 - Test stand offers unique ability to assess different coupling approaches & performance with in-house tools
 - Accuracy & efficiency (speed, memory)
- Feasibility to leverage DOE/CASL product
 - Save development & maintenance cost (for DOE)
 - Leverage open source products
 - Reduced effort to leverage HPC architecture advances
 - Collaboration potential (i.e., UQ, mesh translation, user groups)
 - Maintain consistency w/commercial nuclear where makes sense
 - Leverage economy of scale (software & knowledge) & lessons learned
 - Reduce effort for Regulatory review process

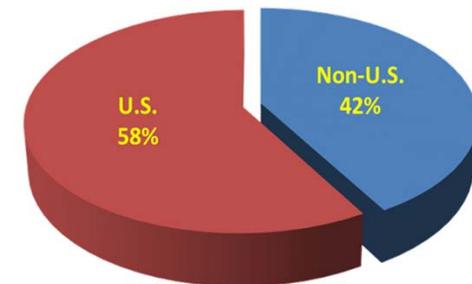
ENERCON Overview

- Overview
 - Employee Owned
 - Founded in 1983
 - 31 Office Locations
 - > 1,600 Employees
 - > 1,200 Employees supporting commercial nuclear power
 - ENERCON supports greater than 80% of nuclear power plants in US through preferred type contracts (85 Units GSA of which 71 are EOC)
- CASL Interests
 - *Reactor physics and fuel performance benchmarking*
 - *SMR natural circulation modeling and simulation*
 - *MSR modeling and simulation*



Electric Power Research Institute – Nuclear Sector Fuel Reliability Program

- EPRI is a 501(c)(3) organization
 - Founded by and for the electricity industry in 1972
 - Independent, nonprofit center for public interest energy and environmental research
 - Collaborative resource organized in 4 sectors: Nuclear, Power Delivery and Utilization, Generation, and Environment & Renewable Energy
- Nuclear Sector Programs:
 - Advanced Nuclear Technology
 - Chemistry, Low-Level Waste, and Radiation Management
 - Equipment Reliability
 - **Fuel Reliability**
 - Long-Term Operations
 - Materials Degradation / Aging
 - Nondestructive Evaluation and Material Characterization
 - Risk and Safety Management
 - Used Fuel and High-level Waste Management
- Fuel Reliability Program
 - Started in 1998 as Robust Fuel Program
 - Renamed FRP in 2004 (shift from high burnup focus)
 - Membership from 18 countries



Rolls-Royce Nuclear Overview

- **Overview**

- Global company providing power/propulsion solutions across aerospace, marine, energy and defense sectors
- Submarine business operating since late 1950s – design, supply and through-life support of nuclear propulsion plants for the UK fleet
- Civil Nuclear business grown since 2008 (working across the whole lifecycle from new design to life extension and decommissioning, including C&I work)
- Most mature reactor analysis capability currently resides in Submarines

- **CASL Interests**

- Particularly development of the VERA suite (coupled code analyses) and advanced in-vessel CFD assessments
- Improved validation data to support future regulatory approval

- **Possible Applications**

- Potential future application of CASL methods in our Civil Nuclear business (SMRs or conventional plants)
- Lessons learned from CASL that could be applied to improve in-house methods in Submarines
- Aim for advanced methods to replace testing or reduce the number of analysis iterations, eventually reducing whole-life cost

See more at: <http://www.rolls-royce.com/products-and-services/nuclear.aspx>



Rolls-Royce

Independent Software Vendor

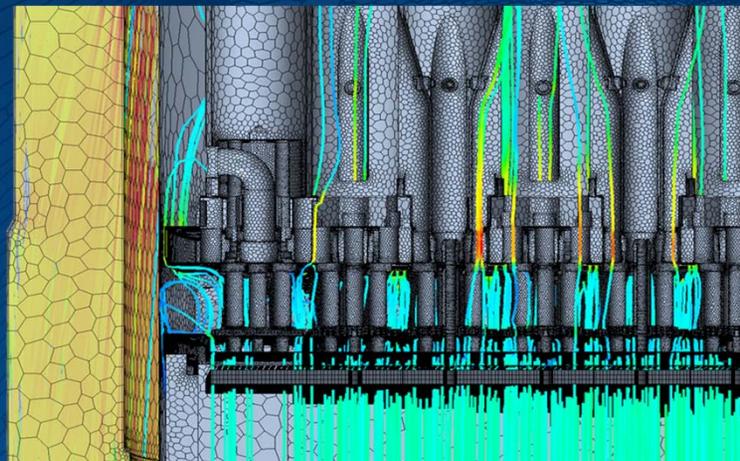
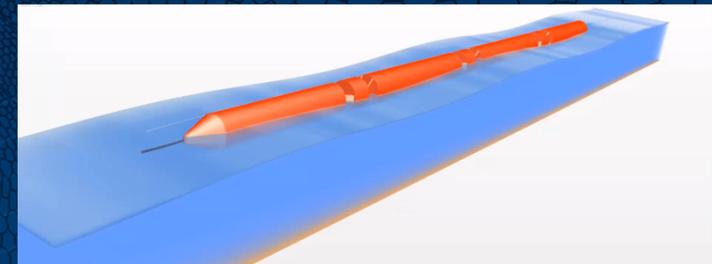
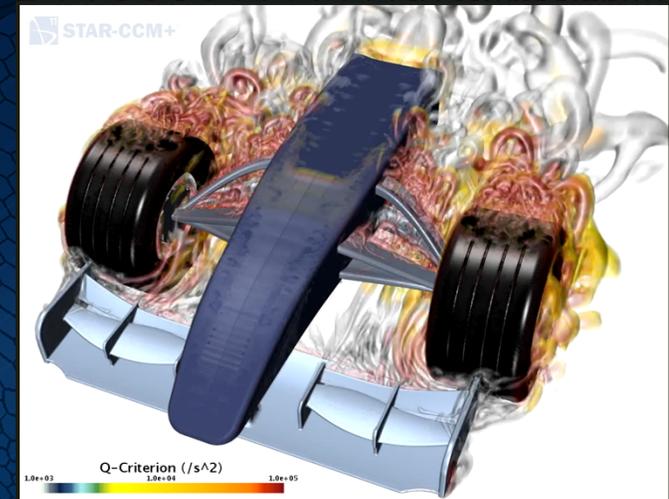




Overview

CD-adapco is a leading global commercial software vendor (HQ Melville, NY) specializing in high fidelity simulation for engineering and design exploration since 1981

- Serve diverse range of industries with prominent presence in nuclear power
- **STAR-CCM+** CFD code is our flagship product
- CASL participant from the beginning
- A **Siemens Business** as of April 1, part of Siemens Digital Factory



Common interest with CASL to accelerate innovation and reduce cost through modeling & simulation

- Collaboration on interoperability
- Leverage STAR-CCM+ industry presence to facilitate VERA useability and use
- Support clients in nuclear power
- Leverage CASL technology in other industries

